

Multi-Scale Remote Sensing Mapping of Anthropogenic Impervious Surfaces: Spatial and Temporal Scaling Issues Related to Ecological and Hydrological Landscape Analyses

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EPA Science Forum 2004

Applied Remote Sensing, JUNE 2, 2004

Introduction: Impervious Surfaces



Fairfax County VA, 2000
Hi-Resolution Digital
Aerial Imagery

Anthropogenic Impervious Surfaces = roads, driveways, sidewalks, parking lots, rooftops, swimming pools, etc.



CWP, 1999

Anthropogenic Impervious Surfaces
act as an indicator;
easily measured and
quantifiable via remote
sensing; of the associated
changes that accompany
development.

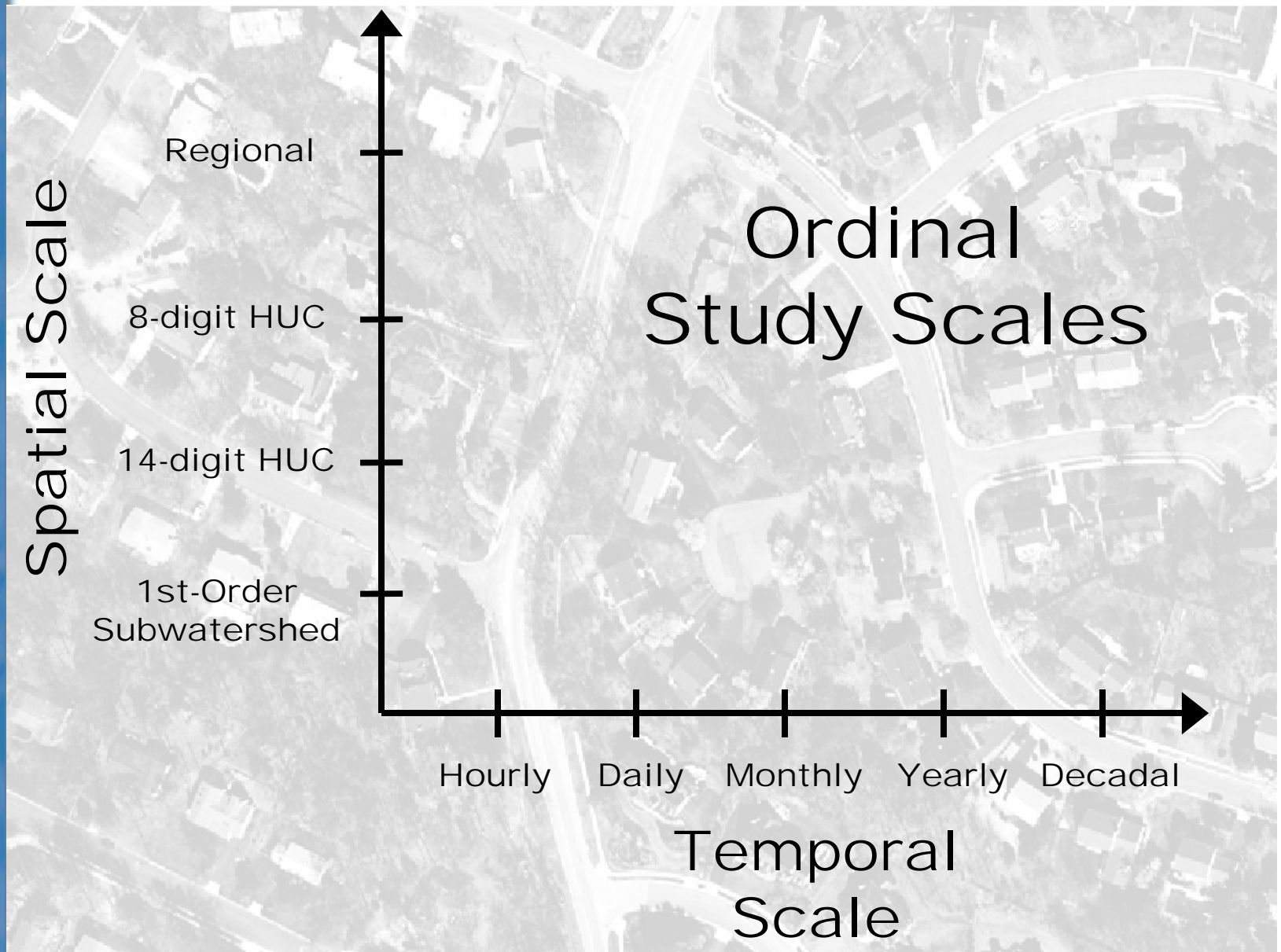


CWP, 1999

Storm water runoff from these features impacts the hydrological, geo-morphological and chemical composition of a stream.



Scales of Study and Impact



Example hydrograph demonstrating the effects of impervious area runoff on peak discharge.

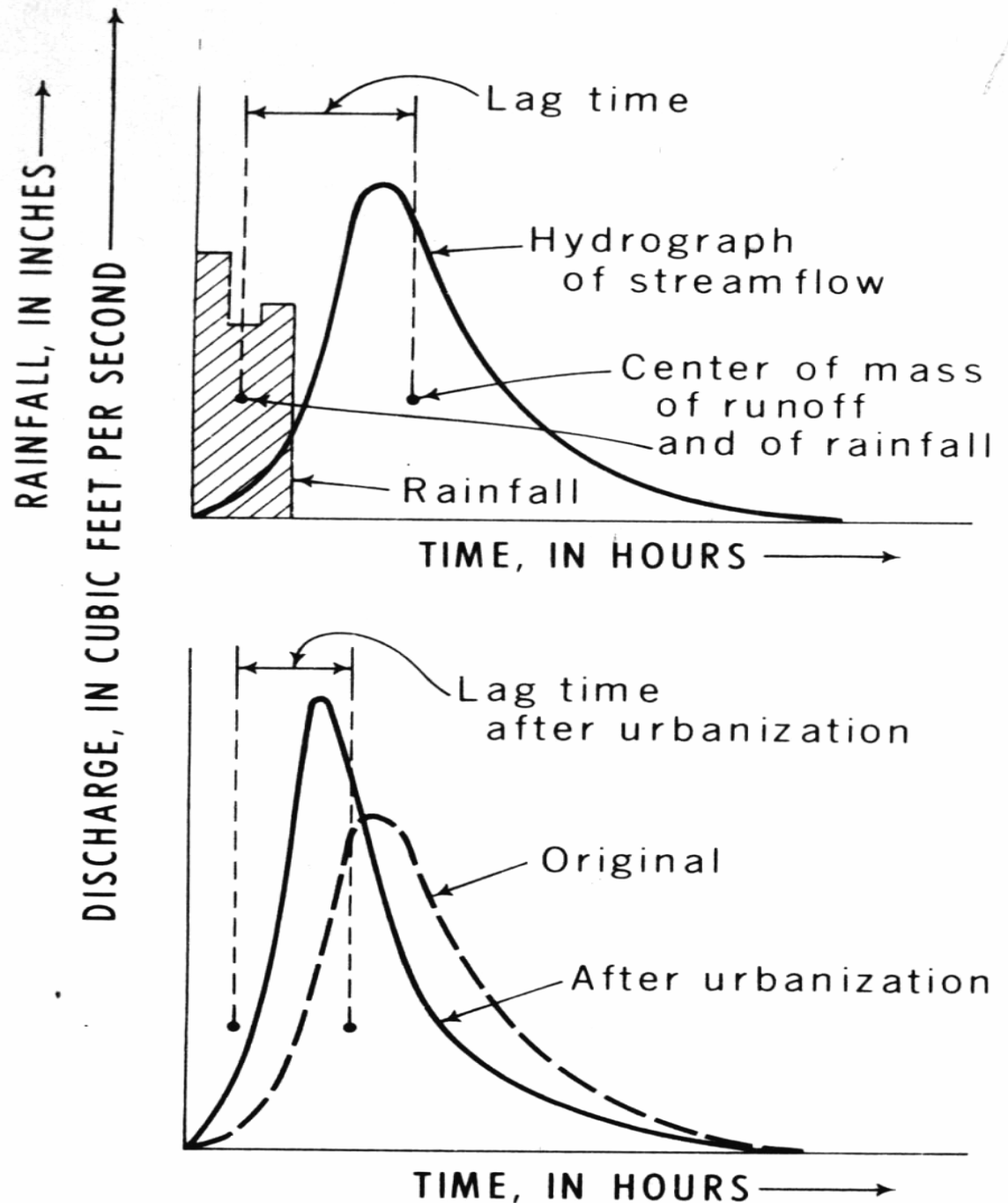
- * Reduced lag time.**
- * Increased peak discharge rate.**

Leopold, 1968

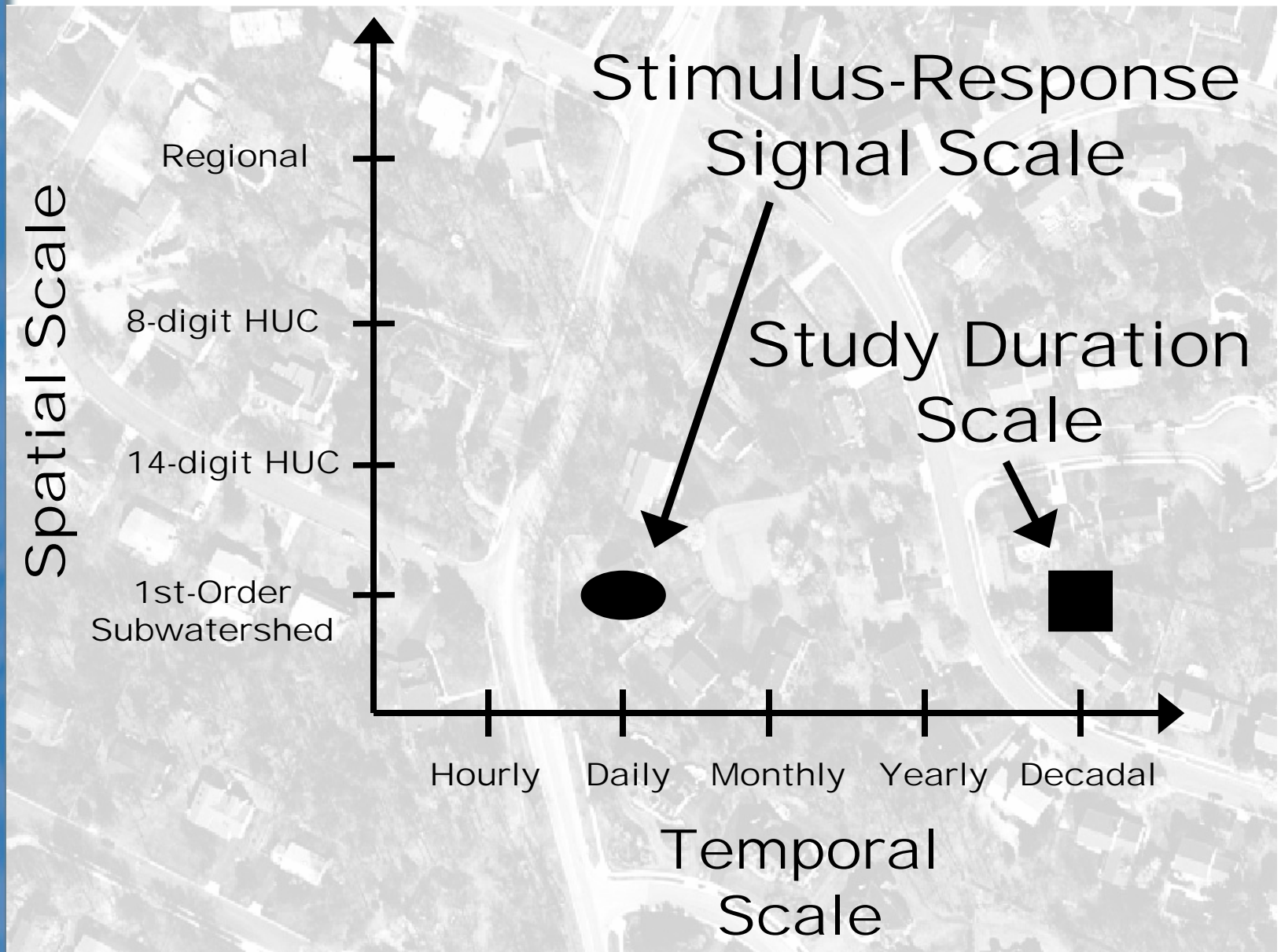
**Time Scale:
minutes - hours**

Increased impervious surfaces also reduce groundwater recharge and increase the total surface water flow

**Time Scale:
hours - months**



Scales of Study and Impact

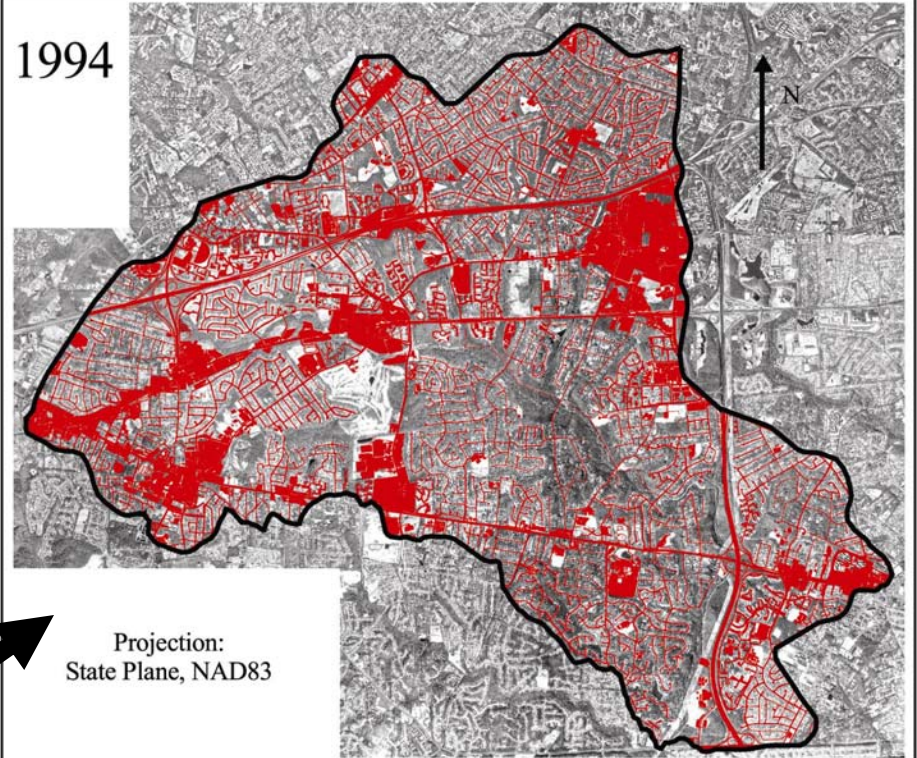


Long Term Studies of Impact

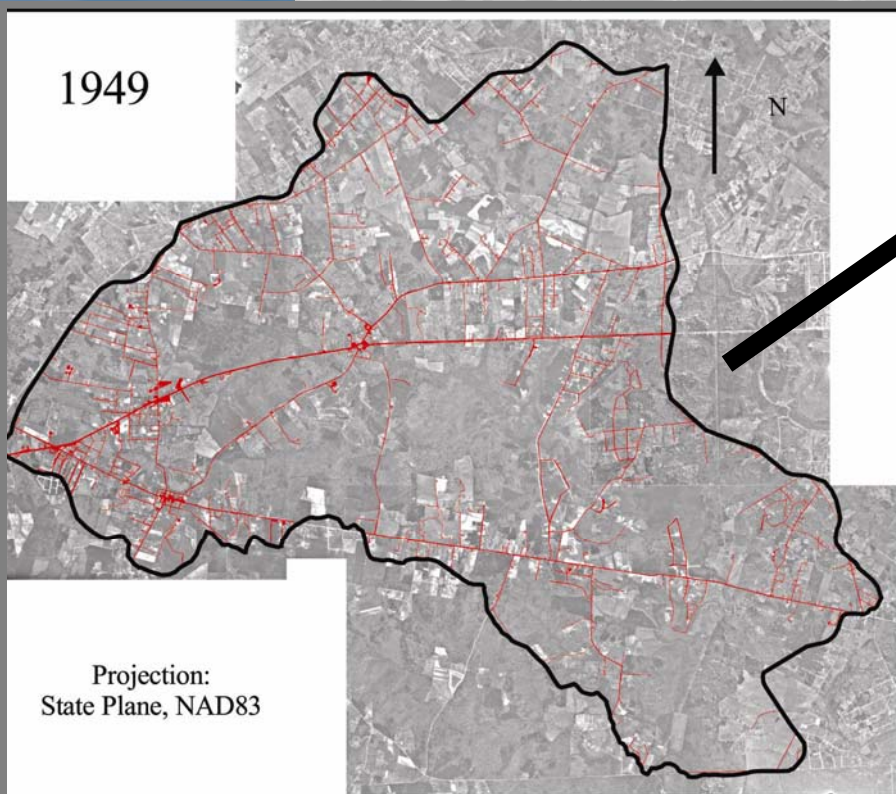
**Upper Accotink,
Vienna VA**

**3 % → 33 %
Anthropogenic
Impervious Surfaces**

1994



1949

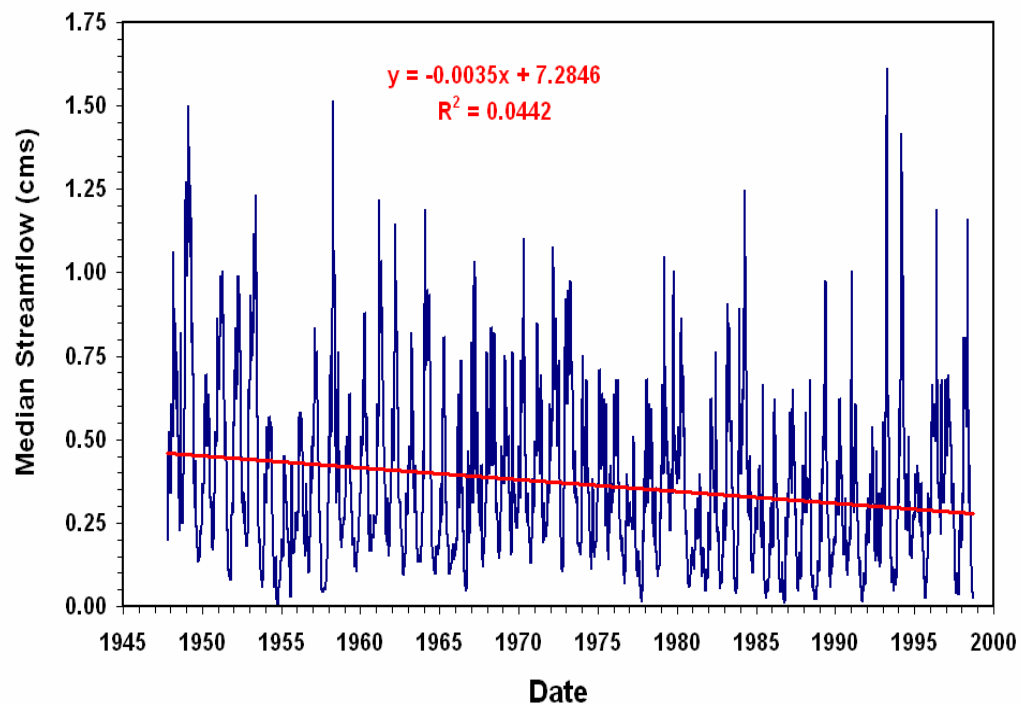


**Remote Sensing Platform:
Historical Aerial
Photography**

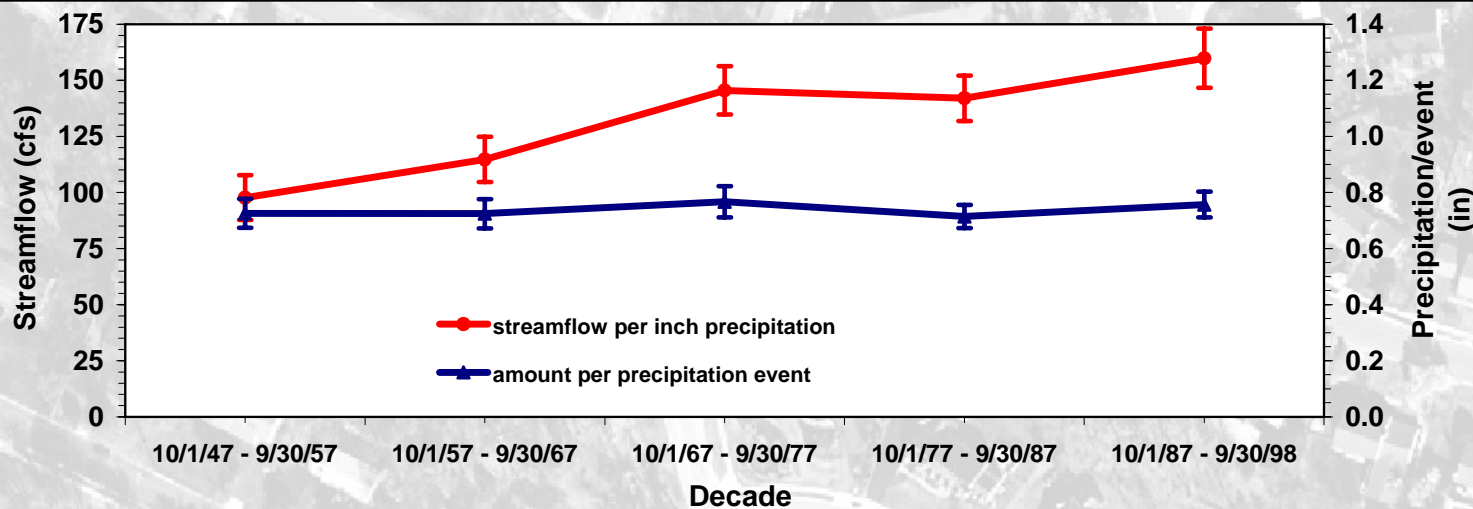
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Upper Accotink – Long Term Effects

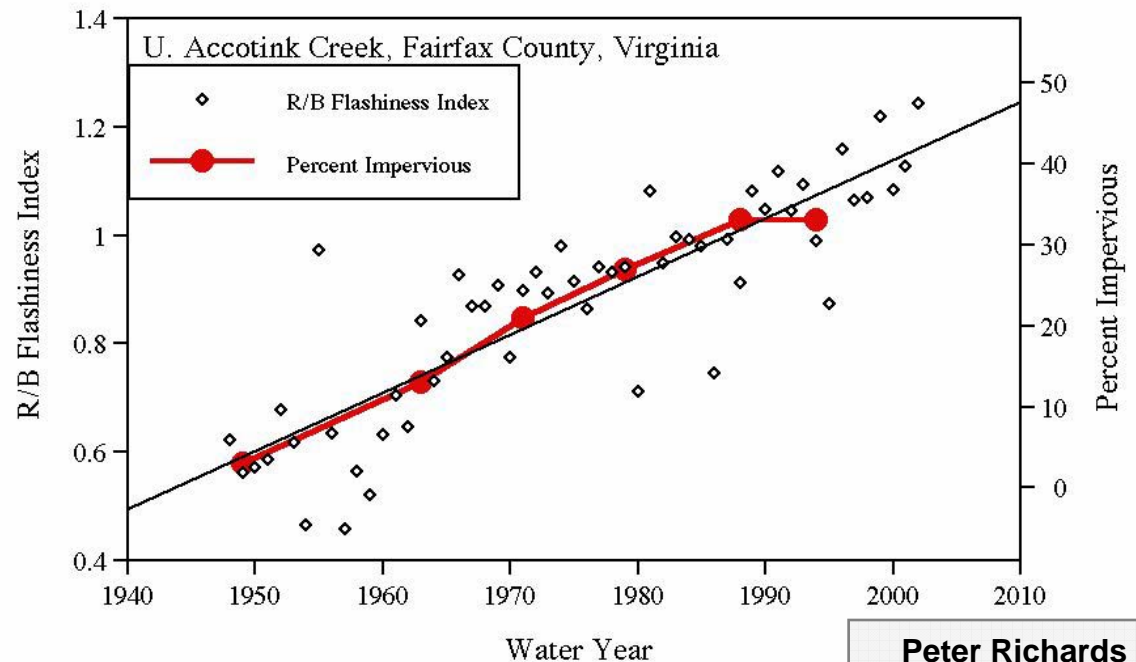


Streamflow (28-day Rolling Median) over Time

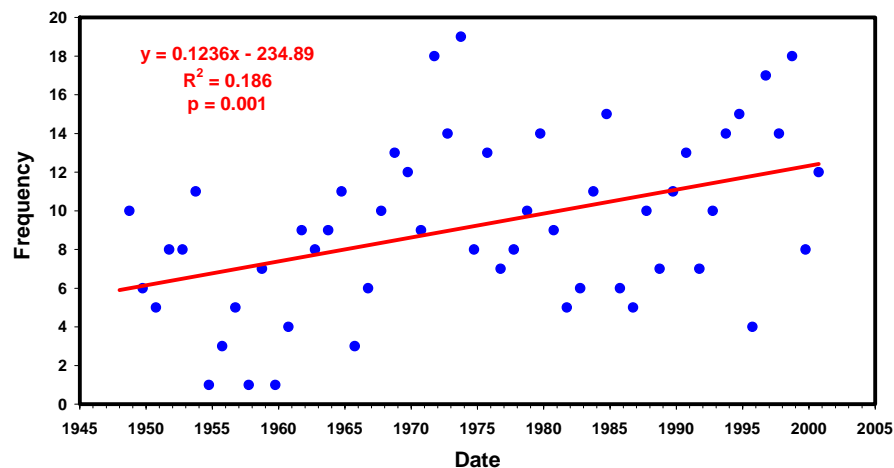


1948 - 1998 Streamflow per Inch of Precipitation

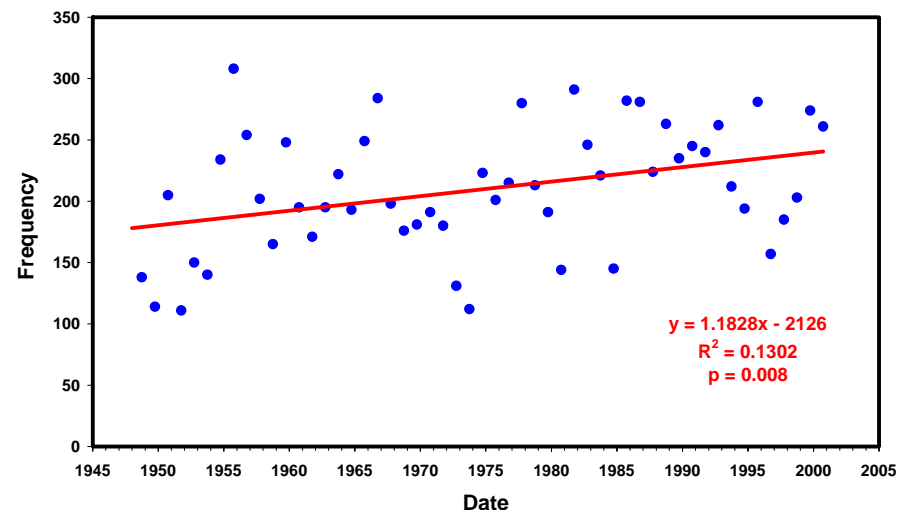
**Upper Accotink –
Long Term Effects:
The number of times
per year that both low
and high flows occur
increase over time.
This has an ecological
effect on stream biota
as well as a physical
effect on stream
morphology.**



**Peter Richards
Heidelberg College**

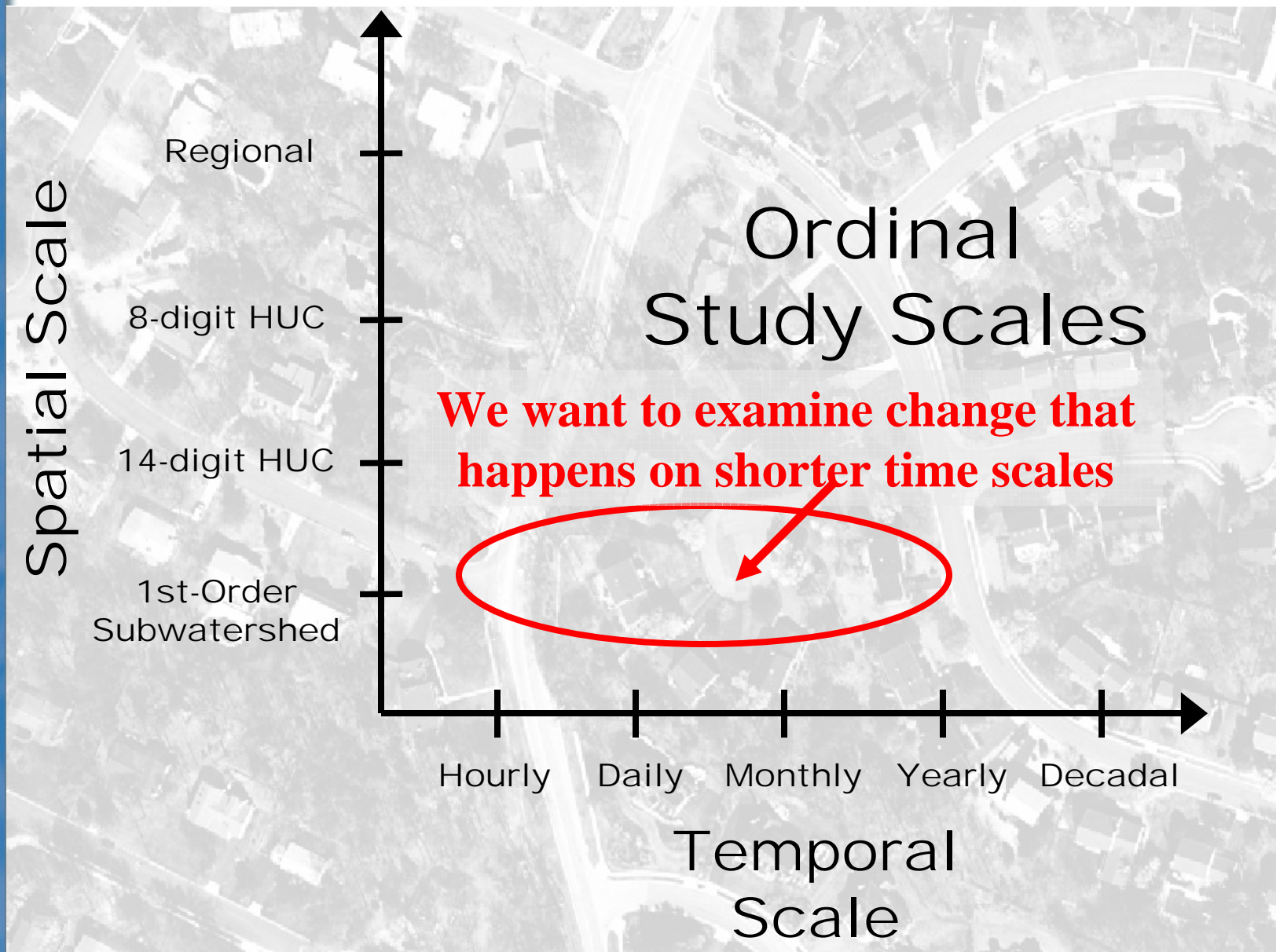


Oct. 1947 - Sept. 2000 Annual (Water-Year)
Frequency of Streamflow > (Mean + (2 * Stdev))
USGS 01654000 ACCOTINK CREEK NEAR ANNANDALE, VA



Oct. 1947 - Sept. 2000 Annual (Water-Year)
Frequency of Streamflow < (Mean/2)
USGS 01654000 ACCOTINK CREEK NEAR ANNANDALE, VA

Scales of Study and Impact

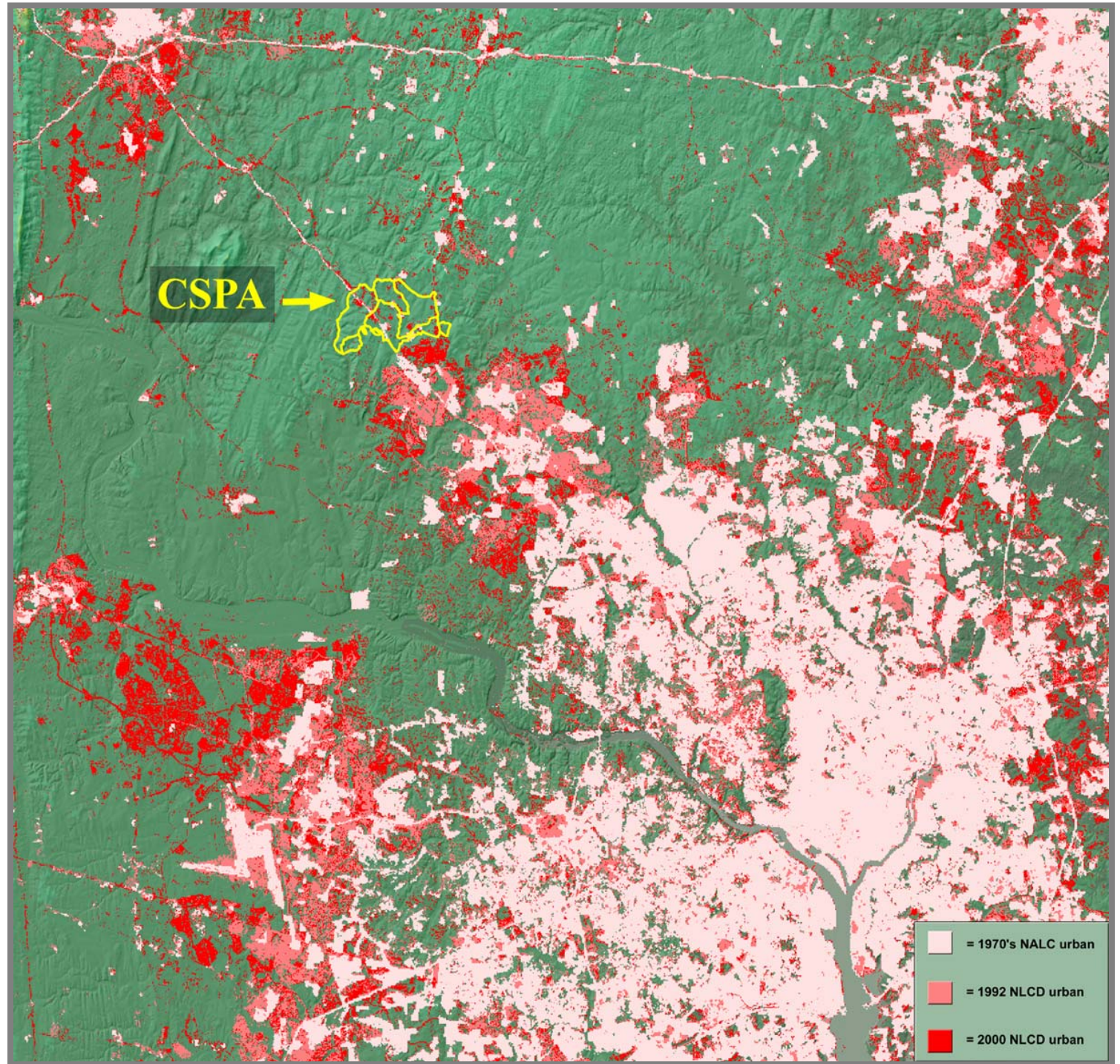


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**30 Years of
Urban
Growth -
NW DC**

**Remote
Sensing
Platforms:
Satellite
Imagery,
Digital
Elevation**



Clarksburg Special Protection Area Collaborative Research: Urban Riparian, BMPs, and Impervious Surfaces - Small Spatial/Temporal Scale

Our research collaborators in this project are:

- 1) USGS ERG, Reston VA and WRD, Baltimore MD**
- 2) Montgomery County, Maryland
Department of Environmental Protection**
- 3) University of Maryland, Baltimore County
Center for Urban Environmental Research and
Education (CUERE)**

Research questions include:

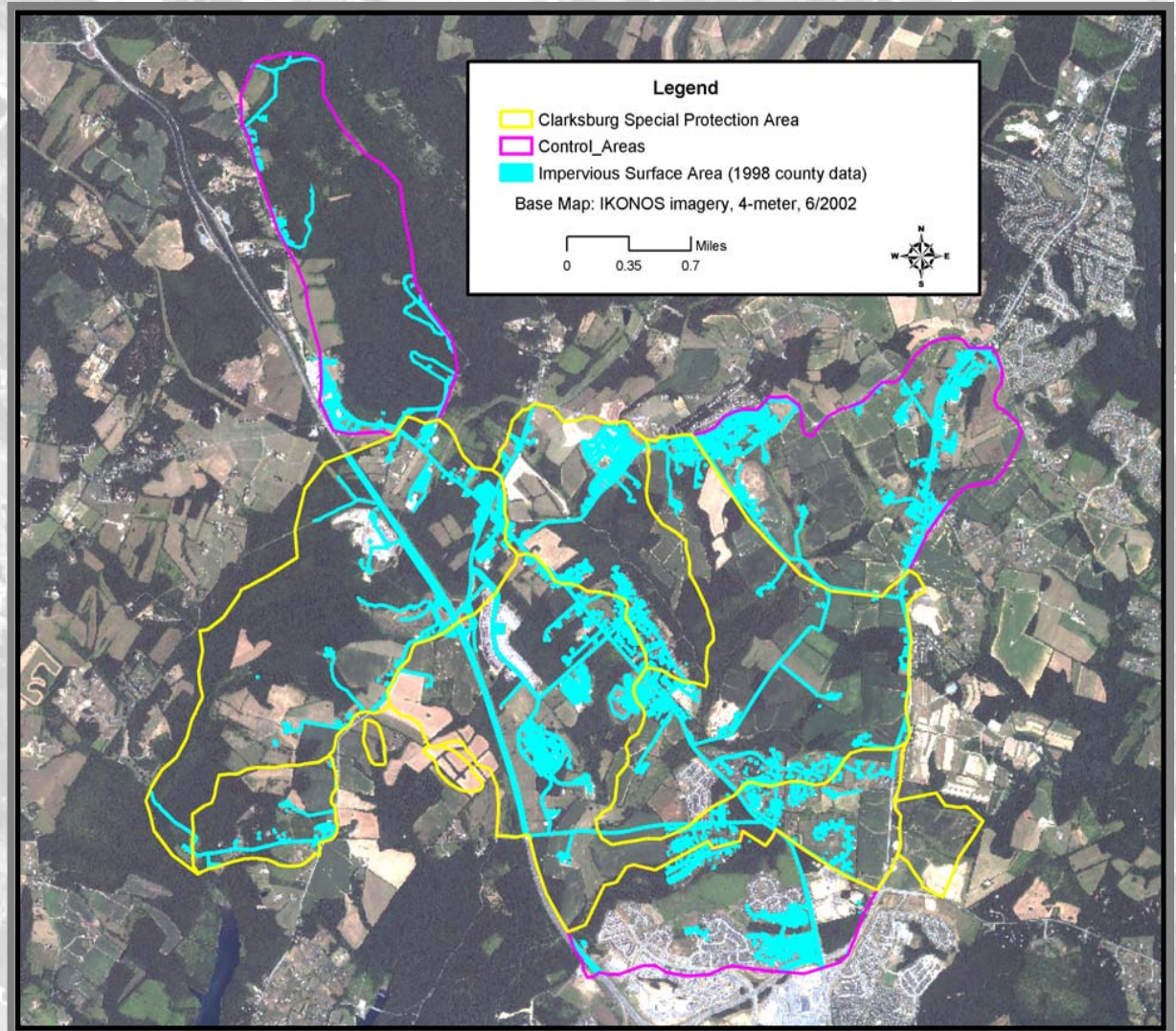
- 1) What effect does an urban riparian zone have?**
- 2) How effective are Best Management Practices (BMPs)?**

Clarksburg SPA Collaborative Research

How can we mitigate the effects of urban development on surface water resources?

**Remote Sensing
Platforms:
LIDAR,
Aerial
Photography,
Satellite Imagery**

**Ground Sensing
Platforms:
Streamflow,
Precipitation,
Water Quality,
Biological Indices**



Chesapeake Bay Collaborative Research: Impervious Surface Mapping Accuracy Assessment - Medium Spatial/Temporal Scale

Our research collaborators in this project are:

- 1) USGS ERG, Reston VA**
- 2) Chesapeake Bay Program, Annapolis, Maryland**

**Research question:
How accurate are
remotely sensed
estimates of
impervious surfaces?**

**Remote Sensing Platforms:
LIDAR, Aerial Photography,
Satellite Imagery**

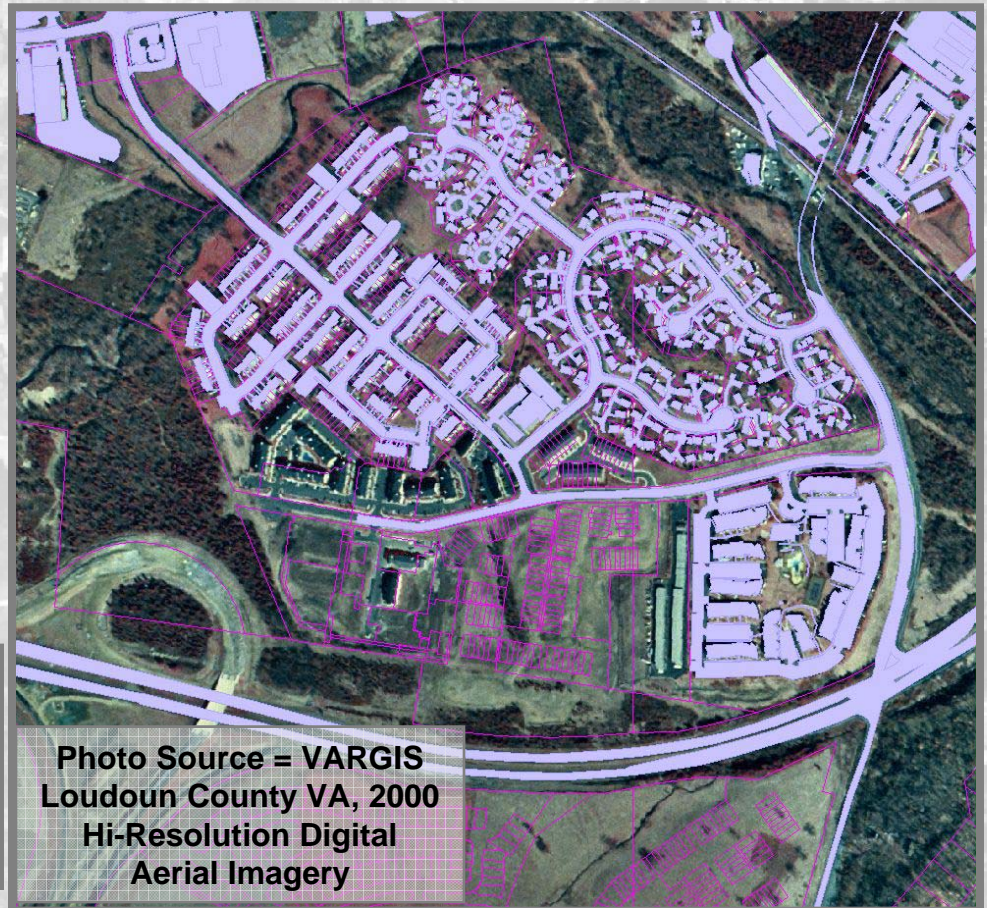
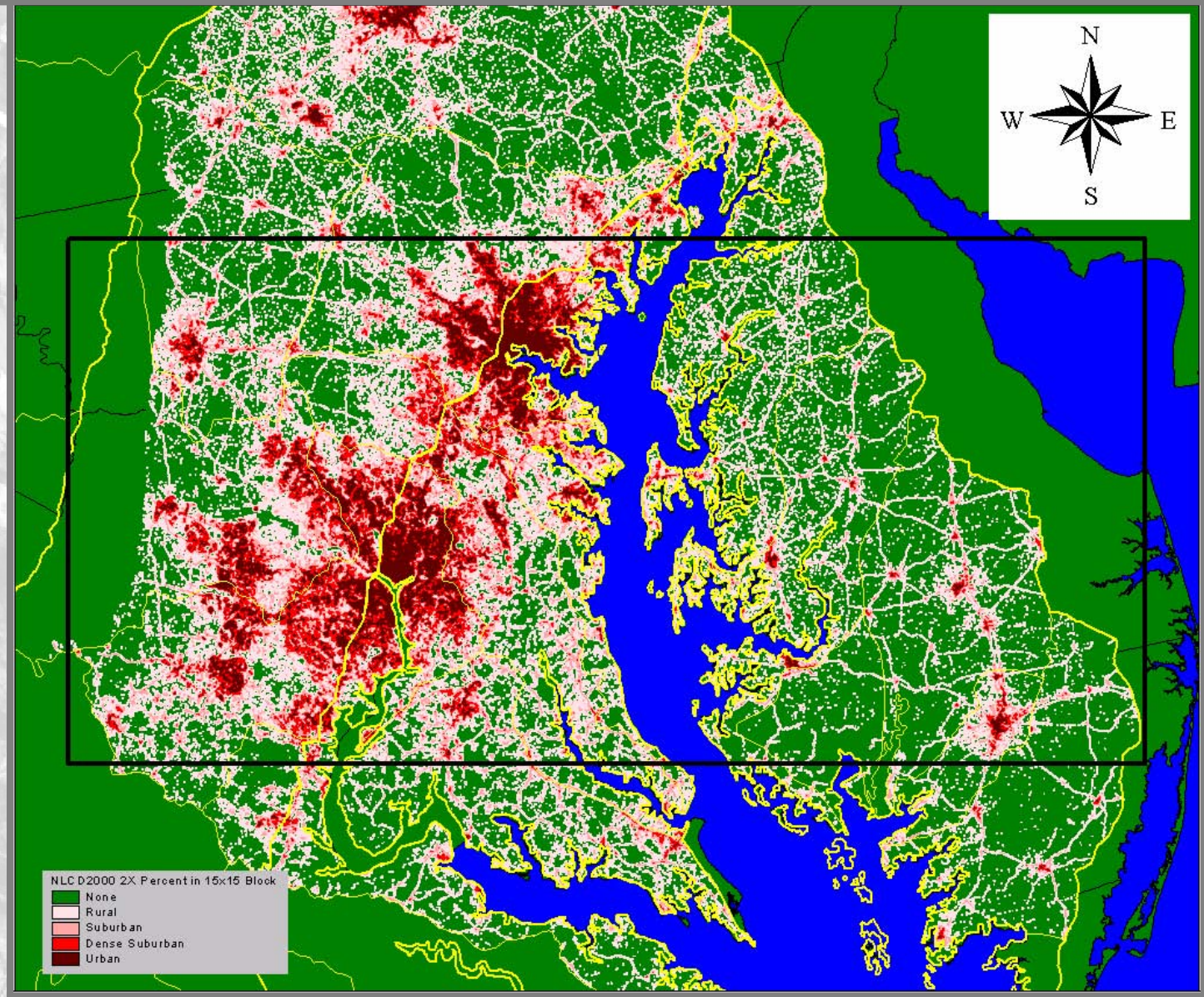


Photo Source = VARGIS
Loudoun County VA, 2000
Hi-Resolution Digital
Aerial Imagery

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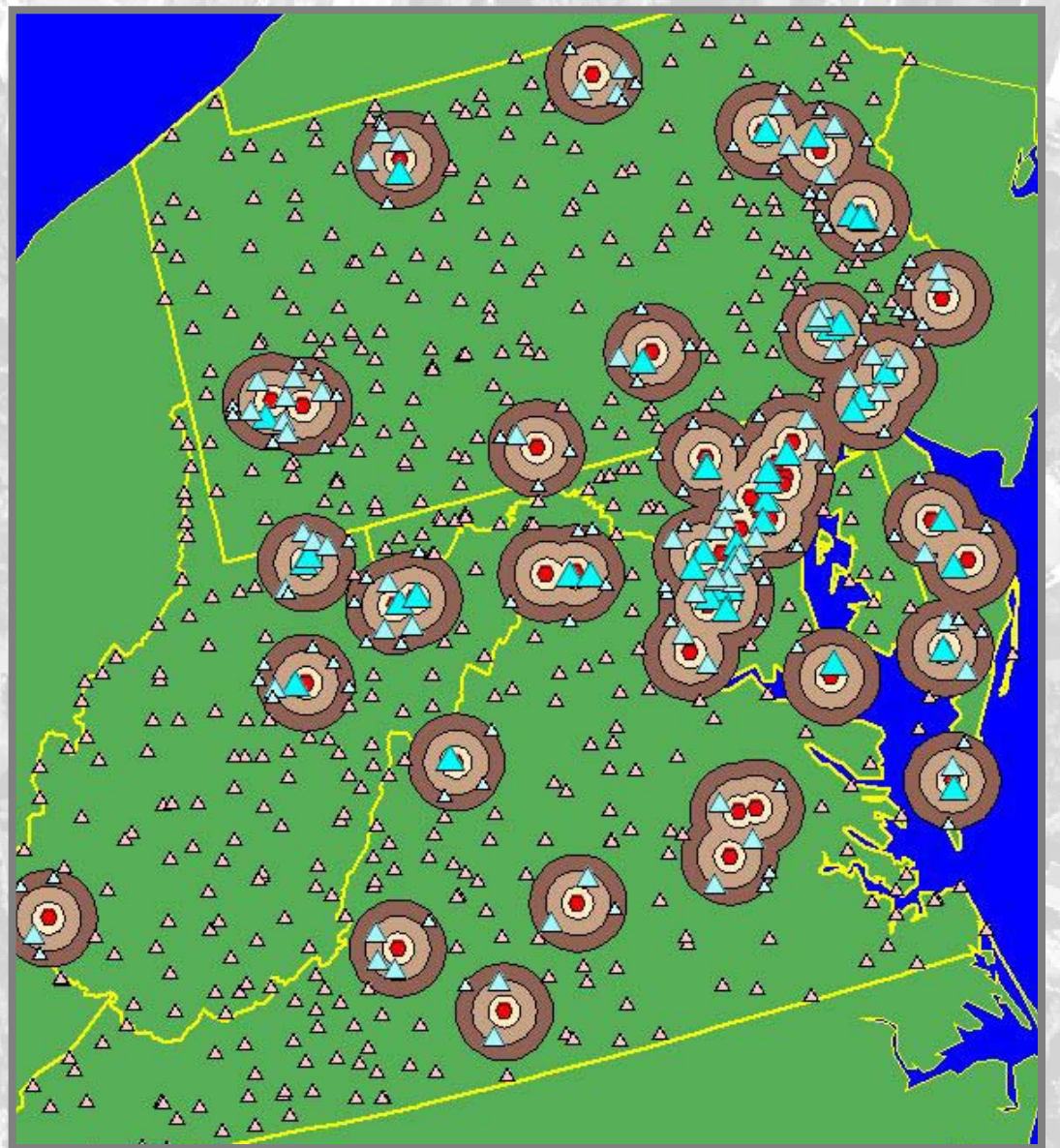
**How, when, and where can we use remotely
sensed estimators of impervious surfaces and
what confidence can we have in them?**



Continuing Research: Historical Impervious Surface Mapping and Streamflow/Precipitation - Large Spatial/Temporal Scale

Research question:
Can we correlate
historical time-series
estimates of impervious
surface change and
development pattern
with observed changes
in streamflow per unit
precipitation over time?

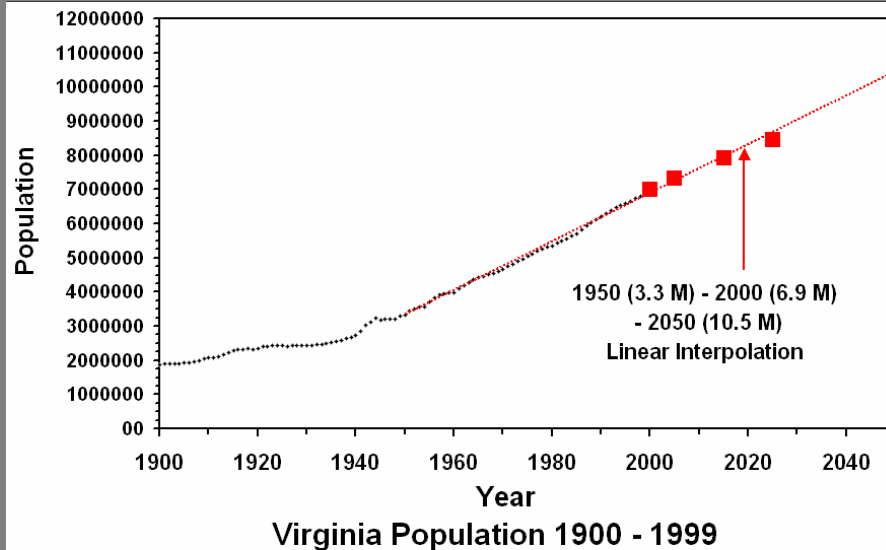
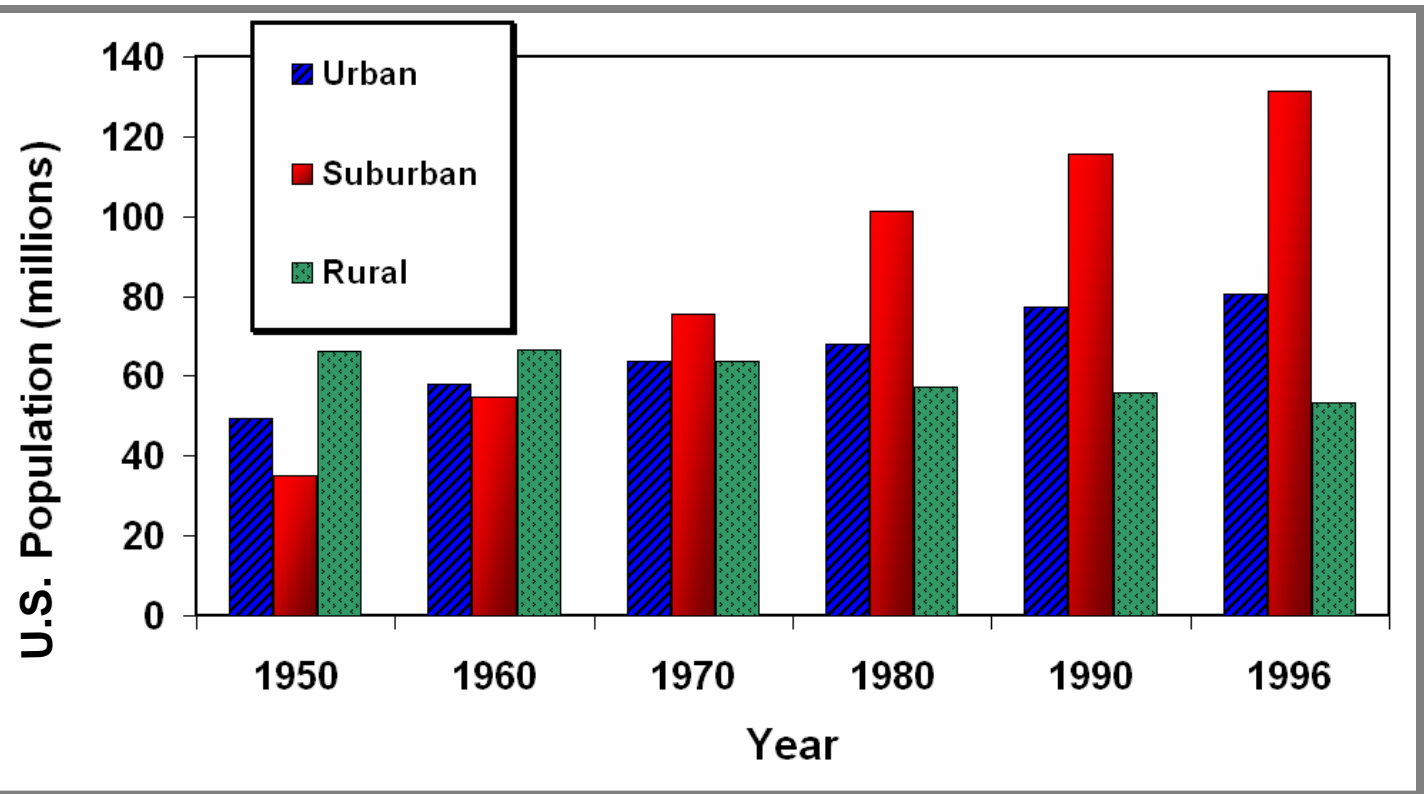
**Remote Sensing
Platforms:**
Aerial Photography,
Satellite Imagery



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Future Trends:



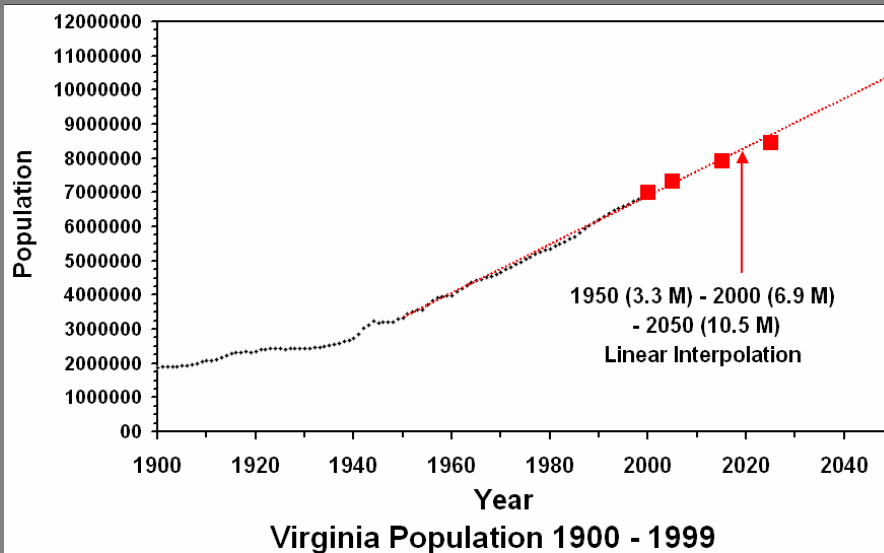
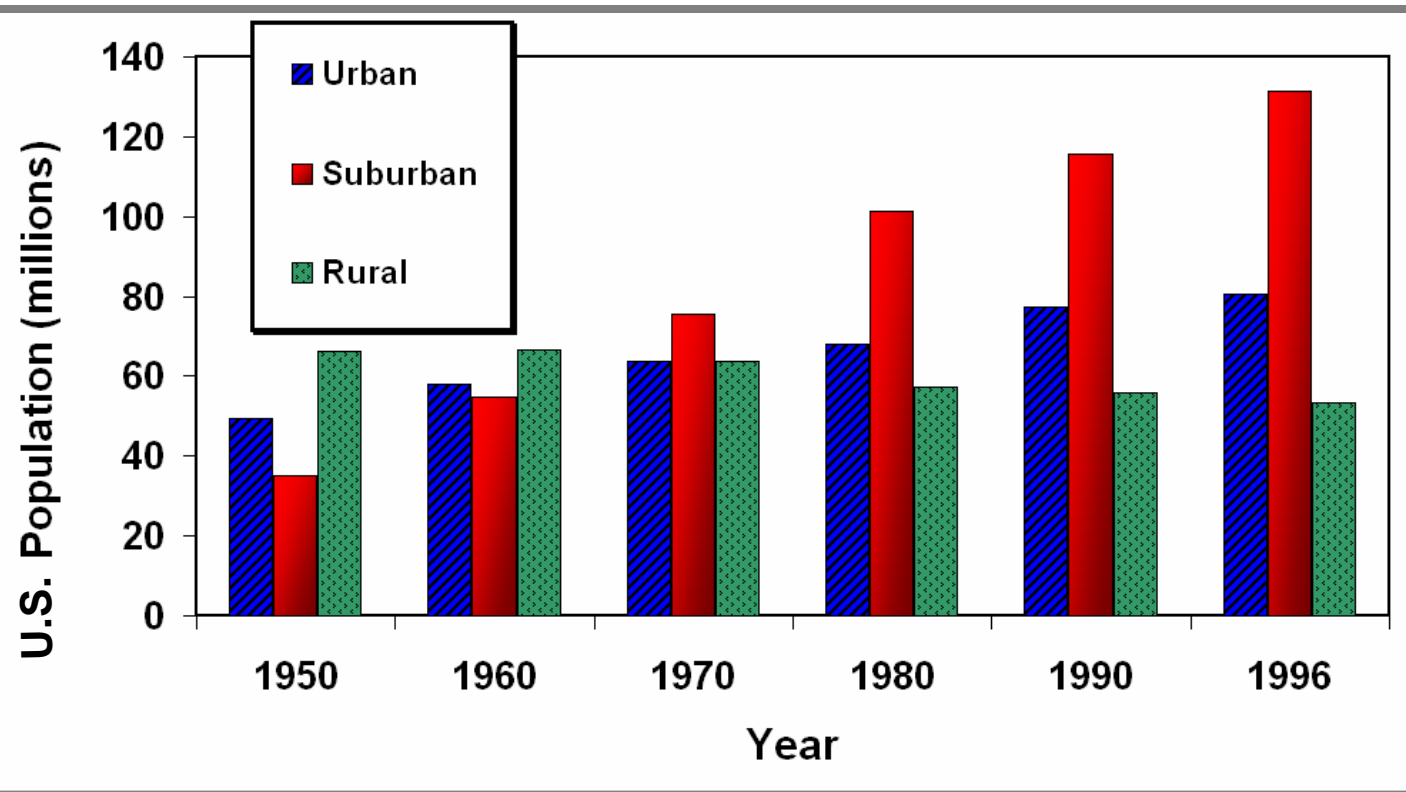
(* = US Census "Series A" 2000 - 2025 projected)

**The Context for
Impervious Surface
Impacts:
Patterns of Urban
Development**

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Future Trends:



(* = US Census "Series A" 2000 - 2025 projected)



Any Questions?